

Nucleonica: Basic, Core and Advanced Applications

Training course with “Hands on” exercises, *To be held at the IRMM JRC Geel, Belgium*

Training Course / Nucleonica Overview

Dr. Joseph Magill,
Nucleonica GmbH,
Karlsruhe



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nucleonica ... web driven nuclear science

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NUCLEONICA HOT TOPICS

» **New! Virtual Cloud Chamber**
November 10, 2011
We announce the release of a new Nucleonica module: the Virtual Cloud Chamber. This powerful application is an online interactive simulation tool for investigating the

What is Nucleonica?

- » Nucleonica is an innovative professional and technical resource for knowledge creation and competence building for the worldwide nuclear science community. The portal has grown to become the leading online resource in the nuclear sciences and is particularly suitable for education and training of young scientists, engineers and technicians in the nuclear domain. Our applications enable researchers and specialists to make complex and precise calculations in state-of-the-art fashion.
- » Nucleonica is aimed at scientists, engineers and technical personnel working in the fields of nuclear power, health physics, radiation protection, nuclear and radiochemistry, decommissioning, nuclear medicine, etc. It can be used by professionals for everyday calculations, obtaining quick results and testing, validating and verifying complex computer models.
- » Nucleonica provides you with user-friendly access to the latest reference data from internationally evaluated nuclear data. A unique feature is the wide range of web-based nuclear science applications. A variety of social networking tools are provided for scientific collaboration. In addition, Nucleonica offers a range of

NUCLEAR NEWS

New telescope to guard Earth from killer asteroids
JUN 30 Some 500,000 asteroids are circulating near-Earth space and some of them may pose a real danger to our planet. But a US company says it plans to build a telescope that will be able to watch them. Read [...]

U.N. publishes report on Iran arms trade with Syria
JUN 30 UNITED NATIONS (Reuters) - A U.N. Security Council committee has published a report on Iranian sanctions violations, including shipments of weapons to Syria in breach of a U.N. ban on weapons exports [...]

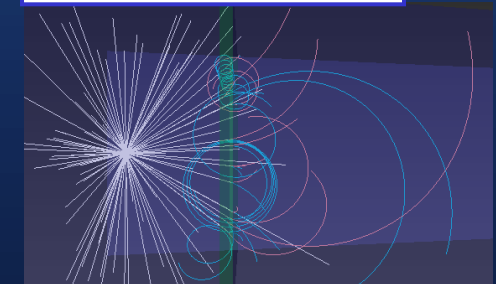
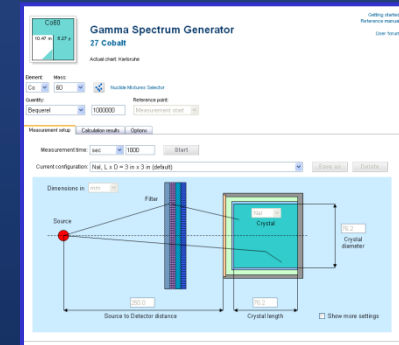
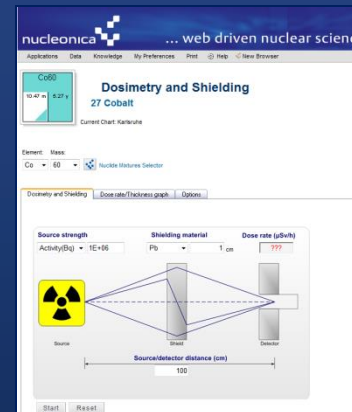
More firms in danger of systems meltdown, claims risk expert
JUN 30 MORE than half of Irish companies are now at risk of an Ulster Bank-style systems meltdown because they are operating increasingly complicated IT systems -- but have failed to commit to the additional [...]

Japan discovers large rare earth deposits
JUN 30 Large and rich rare earth deposits, equaling at least 220 times the country's annual consumption, have been discovered near Minami-Torishima island in the Ogasawara Islands, a research

Nucleonica: Web-based Software Tools for Simulation and Analysis



- Nuclear Data Resources in Nucleonica
- Nuclear Science Applications & Tools
 - Decay Engine
 - Dosimetry & Shielding
 - Virtual Cloud Chamber
 - Gamma Spectrum Generator
 - webKORIGEN
 - e-Ship
- Education & Training with Nucleonica
 - Nucleonica Mobile
 - Karlsruhe Nuclide Chart
- Knowledge Management with Nucleonica



Training courses...



Course Folders...



Introduction to Nucleonica: Core Applications and Tools		
Training course with "Hands on" exercises. To be held at the ORAM JRC desk		
13 June – Core Nucleonica Applications		Index
9:00	Training Course / Nucleonica Overview J. Magill (Nucleonica)	1
9:20	Mass Activity Converter J. Magill	Exercises 2
9:50	Nuclide Mixtures R. Dreher (Nucleonica)	Exercises 3
10:30 – Coffee 10:50	Nuclear Data: from the Karlsruhe Nuclide Chart to Nucleonica Z. Soti (ITU)	Exercises 4
12:30 – Break 13:30	Decay Engine: Decay calculations for single nuclides and mixtures J. Magill	Exercises 5
15:00 – Coffee 15:20	Wiki, Forum, Blog, Glossary: Knowledge Objects Z. Soti	Exercises 6
16:30	Virtual Cloud Chamber: Interaction of particles and photons with matter J. Magill	Exercises 7
17:00 – End of session		
14 June – Core Nucleonica Applications cont'd		
9:00	Gamma Dosimetry & Shielding (D&S) J. Magill	Exercises 8
10:30 – Coffee 10:50	Working with Reference Materials in Nucleonica Z. Soti	Exercises 9
12:30	Feedback/Questionnaire, Certificate	
13:00 – End of Training Course		
Supplementary material:		
Gamma Spectrum Generator + Gamma Libraries		10
webKORGEN		11
e-Ship: Radiological Transport Assistant		12
(Nucleonica Tips & Tricks, additional exercises)		

Nucleonica: Basic, Core and Advanced Applications

Training course with "Hands on" exercises, To be held at the IRMM JRC Geel, Belgium

3 Oct. – Basic & Core Nucleonica Applications

			Index
9:00	Training Course / Nucleonica Overview J. Magill (Nucleonica)		1
9:30	Mass Activity Converter J. Magill	Exercises	2a
10:00	Nuclide Mixtures R. Dreher	Exercises	2b
10:30	Coffee		
10:50	Participants introduction		
11:15	Nuclear Data: from the Karlsruhe Nuclide Chart to Nucleonica, Z. Soti (ITU)	Exercises	3
12:30	Break		
13:30	Decay Engine J. Magill	Exercises	4
15:00	Coffee		
15:20	Virtual Cloud Chamber J. Magill	Exercises	5
16:00	Gamma Dosimetry & Shielding (D&S) J. Magill	Exercises	6
17:00	End of session		

4. Oct. – Advanced Nucleonica Applications

8:30	e-Ship: Radiological Transport Assistant Y. Donjoux (CERN)	Exercises	7
10:00	Coffee		
10:20	webKORIGEN: nuclide depletion calculations J. Zsigrai (ITU)	Exercises	8
11:20	Gamma Spectrum Generator J. Zsigrai	Exercises	9a
12:30	Break		
13:30	Gamma Libraries J. Zsigrai	Exercises	9b
14:30	Wiki, Forum, Blog, Glossary: Knowledge Objects Z. Soti	Exercises	10
15:00	Coffee		
15:20	Working with Reference Materials in Nucleonica Z. Soti	Exercises	11
16:00	Nucleonica Tips & Tricks J. Magill		
16:15	Feedback/Questionnaire, Certificate		
16:30	End of Training Course		
	Supplementary material (additional exercises)		12

These lectures are available online:

http://www.nucleonica.com/wiki/index.php?title=Training_Course_Proceedings

Links to the
presentations:

- go to wiki on main
Nucleonica page

- click on Training
Courses

- at bottom of page
click on Training
Course Proceedings

Oct. 2013 Geel, Belgium

Nucleonica: Basic, Core and Advanced Applications and Tools, 3-4 Oct. JRC IRMM Geel, Belgium, 2013.

This 2-day training course took place at the JRC's Institute for Reference Materials and Measurements (IRMM) in Geel, Belgium during the 3-4 October 2013. The course focused mainly on the Nucleonica Basic, Core and Advanced Applications and tools. A detailed description of nuclear data with particular reference to the various Nucleonica nuclear databases was given. Core applications were demonstrated through the use of Nucleonica tools such as the Decay Engine, and Dosimetry and Shielding. Special emphasis was placed on the Virtual Cloud Chamber application for radiation protection studies and investigating the interaction of charged particles and photons with matter. A case study on Working with Reference Materials showed how the various Nucleonica modules could be combined to fully characterize reference nuclear materials. Key lectures were given by Dr. Jozsef Zsigrai (ITU) on webKORIGEN, the Gamma Spectrum Generator and Gamma libraries and Mr. Yann Donjoux (CERN) on the e-Ship++ radiological transport assistant applications in Nucleonica.

Speakers included Mr. Y. Donjoux (CERN), Dr. Z. Soti and Dr. J. Zsigrai from the JRC/ITU, in addition to Dr. J. Magill and Mr. R. Dreher from the Nucleonica team.

Agenda October 2013

Meet the Trainers for this course

Links to the presentations (to be updated before the course):

[Nucleonica Overview \(J. Magill\)](#)

[Mass Activity Converter \(J. Magill\)](#)

[Nuclide Mixtures \(R. Dreher\)](#)

[Nuclear Data: from the Karlsruhe Nuclide Chart to Nucleonica \(Z. Soti\)](#)

[Decay Engine \(J. Magill\)](#)

[Nucleonica Knowledge Objects: Wiki, Blog, Forum, Glossary \(Z. Soti\)](#)

[Virtual Cloud Chamber \(J. Magill\)](#)

[Gamma Dosimetry & Shielding \(J. Magill\)](#)

[Working with Reference Materials in Nucleonica \(Z. Soti\)](#)

[Nucleonica Tips & Tricks \(J. Magill\)](#)

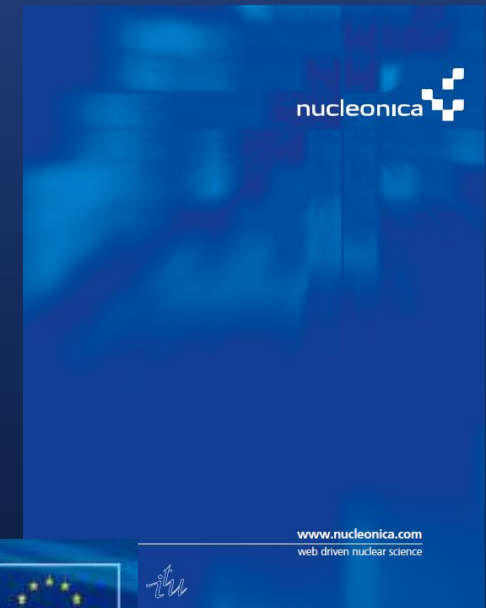


Nucleonica: Basic, Core and Advanced Applications and Tools training course at JRC Geel, Belgium, October 2013

[edit]

How can Nucleonica help you?

- Nucleonica provides you with user friendly access to the latest reference data from internationally evaluated nuclear data.
- A unique feature is the wide range of validated web-based nuclear science applications for decay calculations, dosimetry & shielding, gamma spectrometry, etc.
- In addition Nucleonica offers a range of introductory and advanced training courses in various areas of nuclear science.

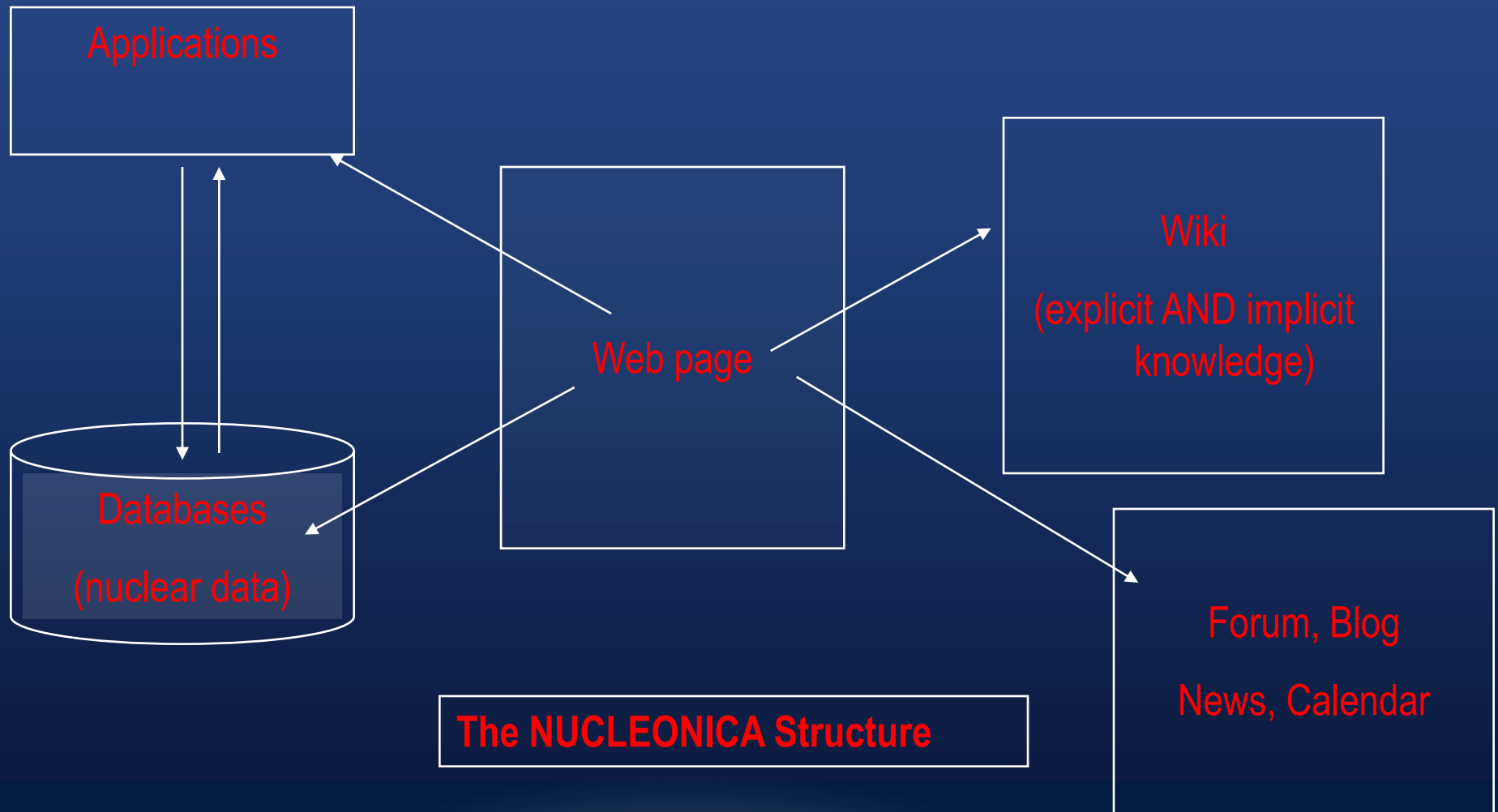


Nucleonica is already being used by thousands of scientists and students worldwide in over 92 countries. Due to its advanced IT features, user friendly and intuitive environment, the platform has recently been endorsed by the Sustainable Nuclear Energy Technology Platform (www.snetp.eu):



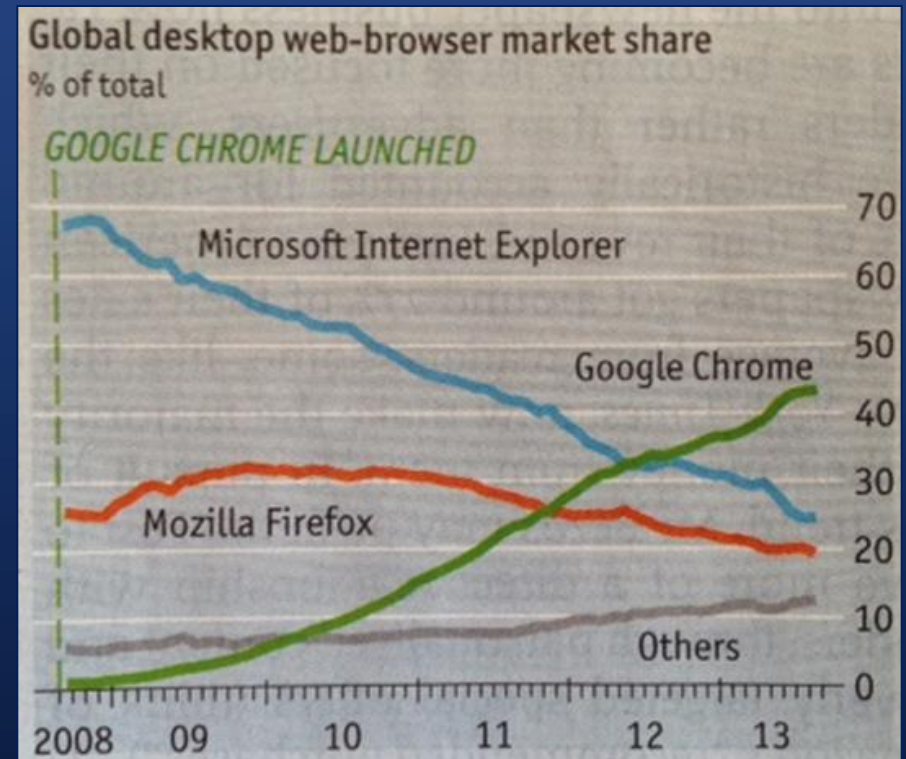
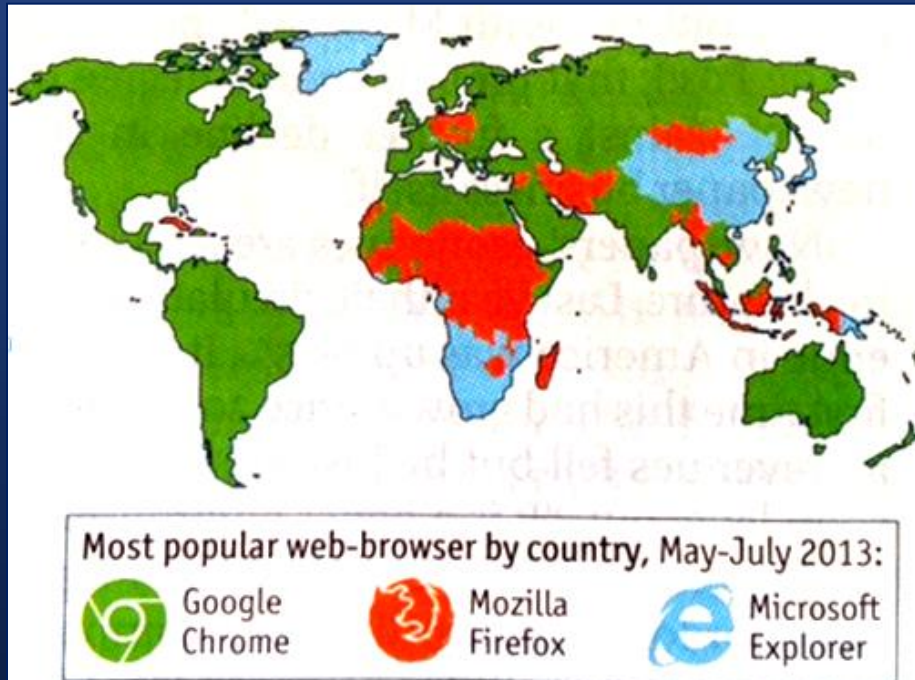
“Nucleonica plays ... an important role in making nuclear education more attractive and in building nuclear knowledge for a new generation of engineers and scientists”

Nucleonica Architecture & Logical Structure...



Which browser?

Nucleonica supports mainly Chrome, Firefox, and IE9, and Safari



Nuclear Data Resources in Nucleonica: Nuclide Datasheets++

Version: 2013.07.26 10:38:01

Questions, remarks, suggestions can be posted in the forum

CPU-Time / Total-Time: 2.9 / 5.1 sec

Reference Data Options Radiations Description Derived Data Cross Sections Prompt Gammas

> Nucleonica Databases

Compare Databases:

	JEFF-3.1	ENDF/B-VII.1	Nubase 2003	Nubase 2012	ICRP-72
60 27 Co ₃₃					
Density					
Mass Excess			-81649.012 (± 828) keV	-81649.720 (± 523) keV	
Atomic Mass			59.933817059 (± 874) u	59.933816299 (± 561) u	
Half-life	5.271 (± 1) y	5.2712000 (± 3833) y	5.2713 y 0.0008	5.2712 y 0.0004	
Spin	5 h	5 h	5+		
Parity	+	+			
Binding Energy			8.74675 MeV/nucleon		
Abundance			-		
Effective Dose Coefficient Inhalation					
Effective Dose Coefficient Ingestion					
Mean Decay Energies					
Alpha	0 (MeV)	0 MeV			
Electron	96.7734 (keV)	96.7691 keV			
Photon	2503.84 (keV)	2503.84 keV			
Decay					
Co60 (β-) 28 Ni 60					
Branching ratio	1	1			
Decay Energy, Q	2.8239 (MeV)	2.8239 (MeV)			
Decay Production					
27 Co 60m (IT) Co60					
Branching ratio	0.9975	0.9976			
Decay Energy, Q	0.0586 (MeV)	0.058603 (MeV)			

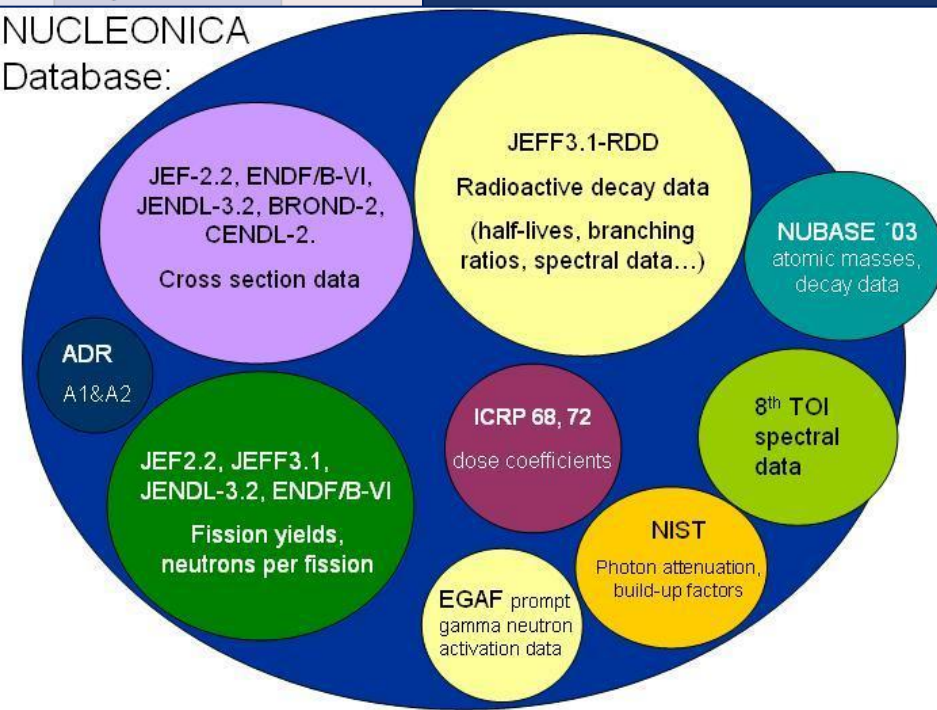
Download ☒ Excel ☐ CSV Separator: ☒ Use field qualifier (")

60
27 **Co**₃₃ ☒ gamma ☐ beta⁻ ☐ discrete e⁻ ☐ X-rays & annihilation

Type	Energy(keV) JEFF-3.1	Energy(keV) ENDF/B-VII.1	Emission Probability JEFF-3.1	Emission Probability ENDF/B-VII.1
γ	1332.490 (± 0.004)	1332.492 (± 0.004)	9.998260e-1 (± 6.0e-6)	9.998260e-1 (± 6.0e-6)
γ	1173.230 (± 0.003)	1173.228 (± 0.003)	9.9850e-1 (± 3.0e-4)	9.9850e-1 (± 3.0e-4)
γ	826.100 (± 0.030)	826.100 (± 0.030)	7.60e-5 (± 8.0e-6)	7.60e-5 (± 8.0e-6)

Main Nucleonica database JEFF3.1 contains decay data on 3852 nuclide.

NUCLEONICA Database:



Nuclear Data Resources in Nucleonica:

Nuclide Datasheets++

User friendly access to internationally evaluated nuclear data
with Nucleonica's Nuclide Datasheets++

» Nuclide Datasheets++ is an innovative user-friendly web-based application for displaying nuclear decay data from internationally evaluated data libraries such as JEFF3.1, ENDF/B-VII.1, etc. Through the use of filters, different types of spectral data (gamma, alpha, beta, etc.) from different sources can be compared.

» It is aimed at professionals for fast lookup of relevant nuclear data. Nuclide Datasheets++ is particularly suitable for education and training of young scientists, engineers and technicians in the nuclear domain.

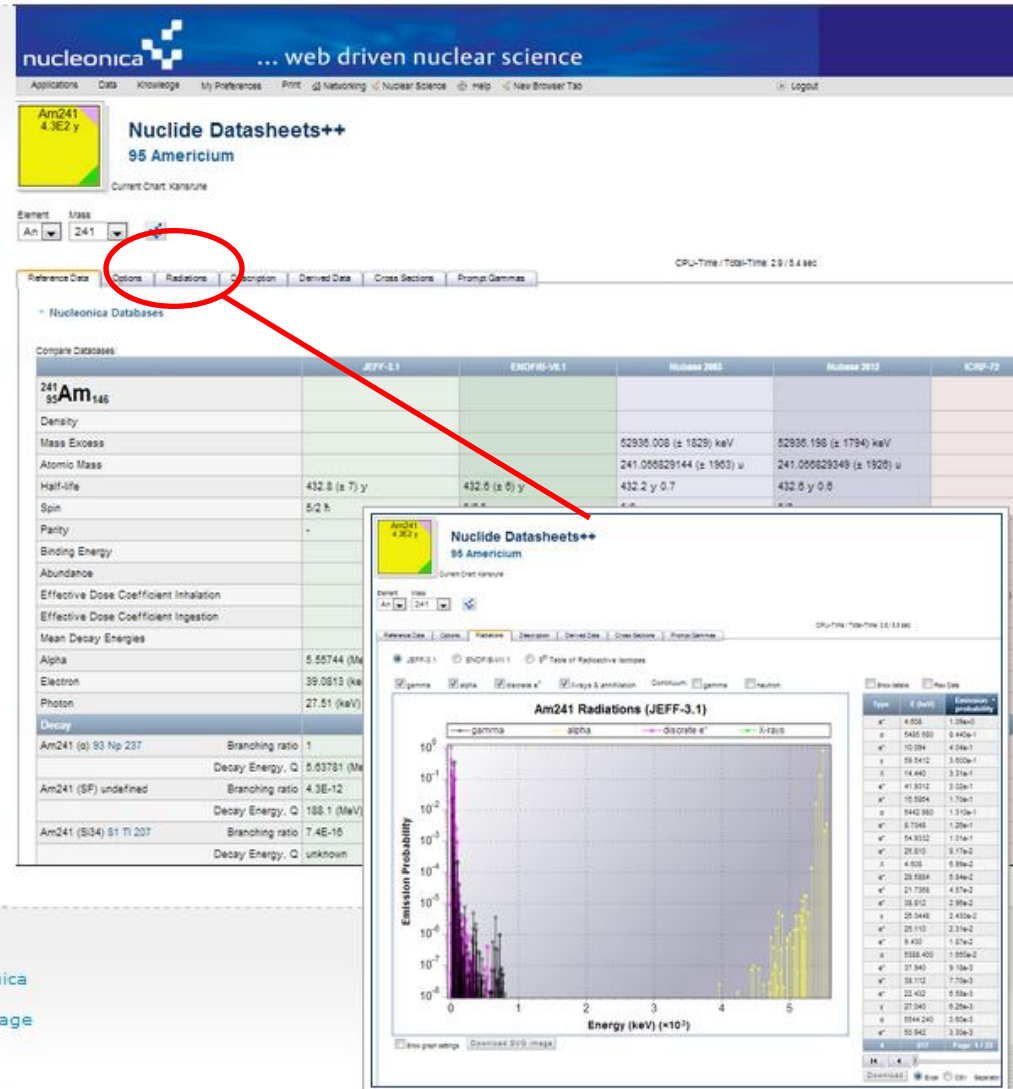
» Datasheets++ is ideal for physicists, chemists, and technical experts from the nuclear industry, nuclear research organizations, universities, regulatory authorities and nuclear medicine institutes. It can be used in the fields of radiation protection, health physics, radiochemistry, nuclear waste characterization, decommissioning, nuclear security, nuclear forensics, nuclear medicine, etc.

» Register now for Free access to test the Datasheets++

Further information...

- [More information on Nucleonica](#)
- [Nucleonica brochure](#)
- [Nuclide Datasheets++ wiki page](#)
- [Nucleonica Blog](#)

Contact us at info@nucleonica.com



Validated Nuclear Science Applications & Tools

Decay Engine++



... web driven nuclear science

Radioactive Decay Calculations with Nucleonica's Decay Engine++

» Nucleonica's Decay Engine++ is an innovative user-friendly web-based application for investigating the radioactive decay of nuclides and nuclide mixtures. It is based on the exact mathematical solution to the Bateman equations.

» It is suitable for professionals for everyday calculations and for testing, validating and verifying complex computer models. The Decay Engine++ is particularly suitable for education and training of young scientists, engineers and technicians in the nuclear domain.

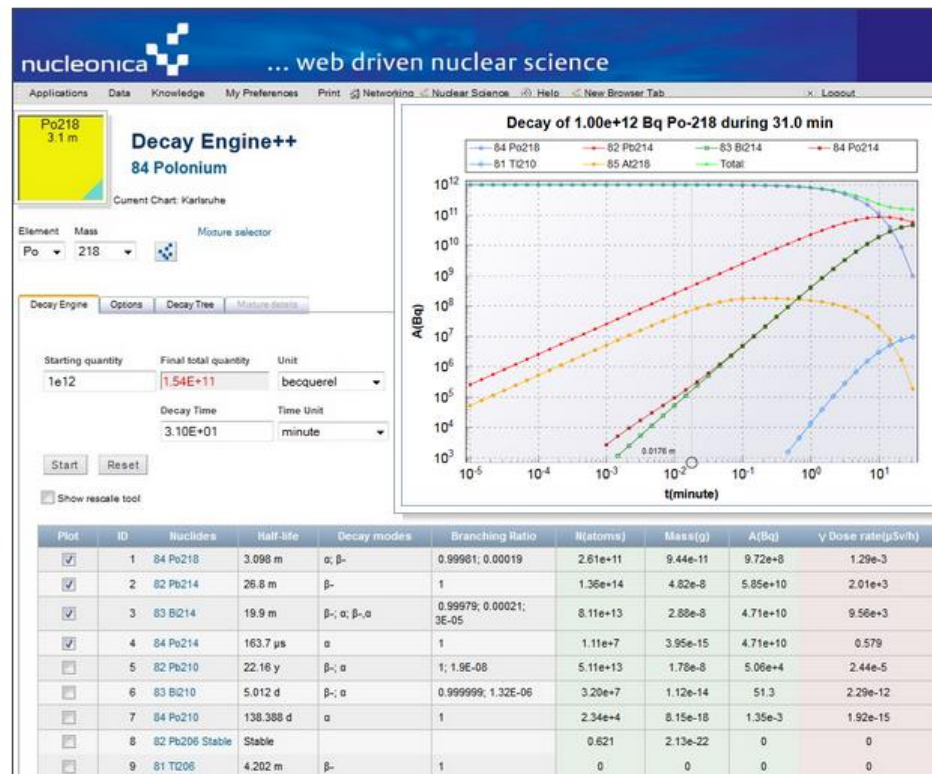
» Decay Engine++ is ideal for physicists, chemists, and technical experts from the nuclear industry, nuclear research organizations, universities, regulatory authorities and nuclear medicine institutes. It can be used in the fields of radiation protection, health physics, radiochemistry, nuclear waste characterization, decommissioning, nuclear security, nuclear forensics, nuclear medicine, etc.

» [Register now for Free access to test the Decay Engine++](#)

Further information...

- [More information on Nucleonica](#)
- [Nucleonica brochure](#)
- [Decay Engine++ wiki page](#)
- [Nucleonica Blog](#)

Contact us at info@nucleonica.com



Radiation dosimetry and shielding calculations

with Nucleonica's Dosimetry & Shielding++

Validated
Nuclear
Science
Applications
& Tools

Dosimetry
&
Shielding++

» Nucleonica's Dosimetry & Shielding++ is an innovative user-friendly web-based application for investigating the gamma dose rates from radioactive nuclides and nuclide mixtures based on the point source kernel method. More than 1300 gamma and X-ray emitting nuclides with 53,000 gamma and X-rays are available in the Nucleonica database, together with data for ten different shield materials and their associated buildup factors.


» It is suitable for professionals for everyday calculations and is suitable for education and training of young scientists, engineers and technicians in the nuclear domain.

» Dosimetry & Shielding++ is ideal for physicists, chemists, and technical experts from the nuclear industry, nuclear research organizations, universities, regulatory authorities and nuclear medicine institutes. It can be used in the fields of radiation protection, health physics, radiochemistry, nuclear waste characterization, decommissioning, nuclear security, nuclear forensics, nuclear medicine, etc.

» Register now for Free access to test the Dosimetry & Shielding++

Further information...

- [More information on Nucleonica](#)
- [Nucleonica brochure](#)


... web driven nuclear science

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Co60

10.47 m 5.27 y

Dosimetry and Shielding

27 Cobalt

Current Chart: Karlsruhe

Element Mass

Co 60

Mixture select

☐ Include daughters

Nuclide	Gamma Energy (keV)	Emission Probability P (per disintegration)	Mass Attenuation Coefficient (shielding)(cm ² /g)	Number of Mean Free Paths (μd)
27 Co 60	1332.49	1.00E+00	5.64E-02	6.40E-01
27 Co 60	1173.23	9.99E-01	6.20E-02	7.04E-01
27 Co 60	826.1	7.60E-05	8.59E-02	9.75E-01
27 Co 60	2158.57	1.20E-05	4.54E-02	5.15E-01
27 Co 60	347.14	7.50E-05	3.05E-01	3.40E+00
27 Co 60	2505.69	2.00E-08	4.39E-02	4.99E-01
27 Co 60	7.47815	6.44E-05	2.71E+02	3.07E+03
27 Co 60	7.46089	3.27E-05	2.72E+02	3.09E+03
27 Co 60	8.26	1.31E-05	2.11E+02	2.40E+03
27 Co 60	0.85	1.49E-06	7.16E+03	8.12E+04

10 Radiations Page: 1 / 1

Dosimetry and Shielding

Dose rate/Thickness graph

Options

Mixture details

Initial source strength

Activity(Bq) 1E+06

Shielding material

Pb 1 cm

Dose rate (μSv/h)

2.67E-01



Source

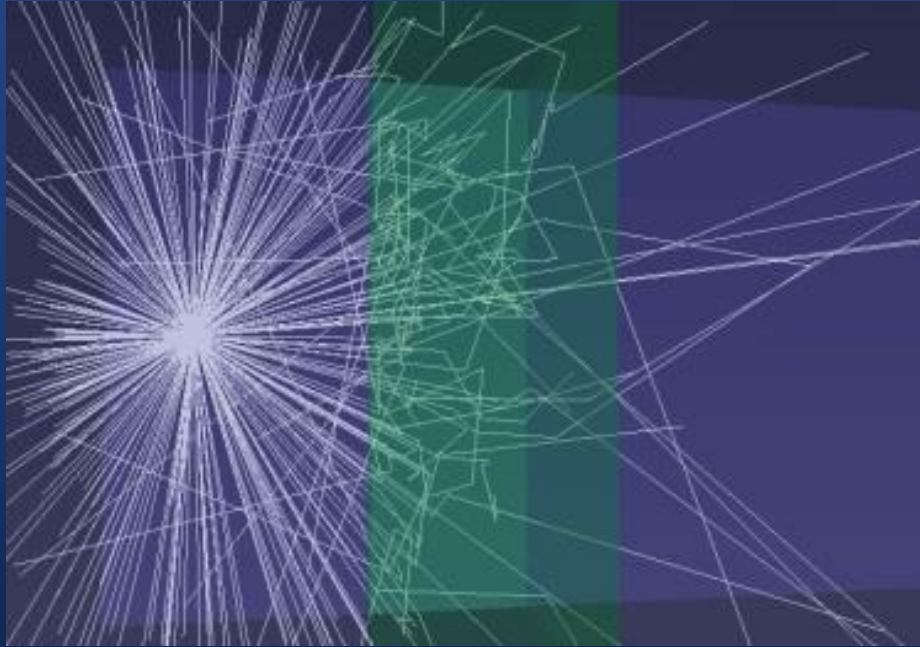
Shield

Detector

Source/detector distance (cm)

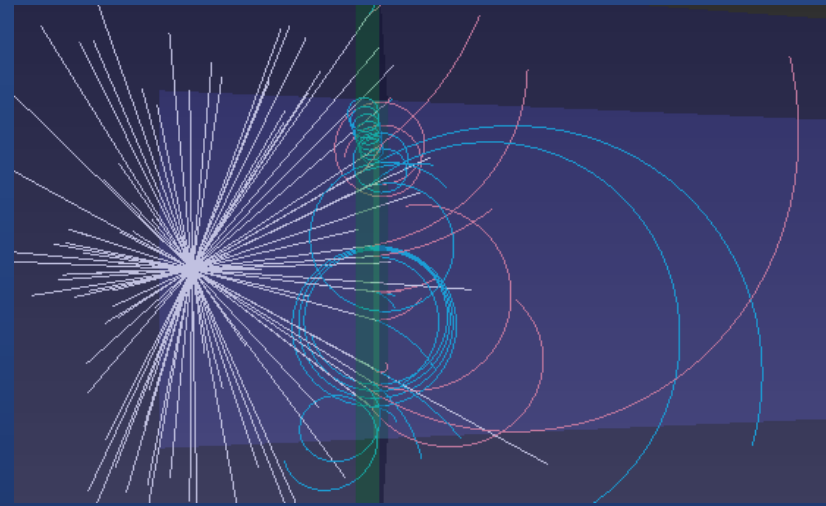
100

Virtual Cloud Chamber

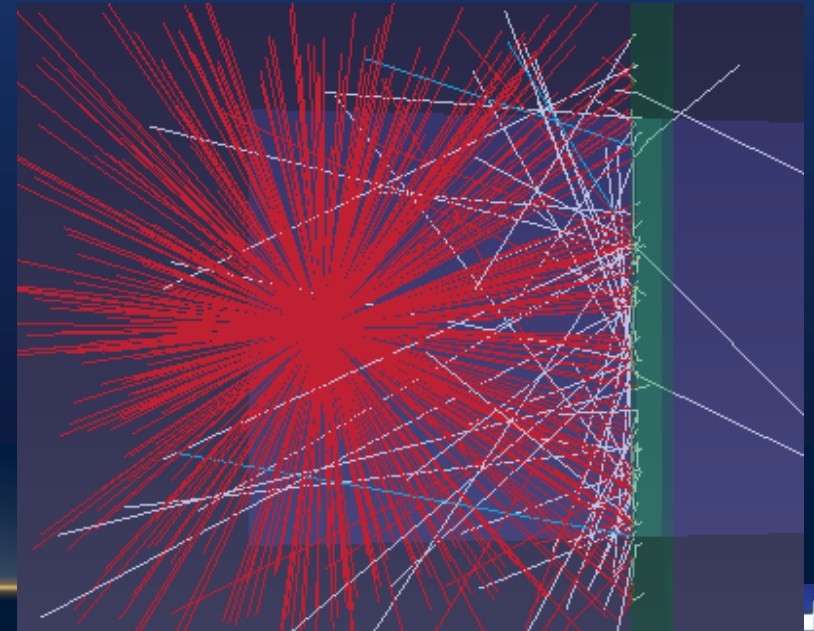


low energy photons (energy 100 keV) are attenuated with a thick (15 cm) water shield. This combination of low energies and thick shields give rise to multiple scattering of the radiation

The red particles (3 MeV positrons) are blocked by a lead shield (green). When the positrons collide with the shield, they combine with electrons (blue) to create gamma radiation (white). Only a few gamma photons pass through the shield material.



Electron-positron pairs are created using 10 MeV photons on lead. By “switching off” energy loss mechanisms, the charged particles are seen to spiral in the applied magnetic field.



Some animations made with the VCC



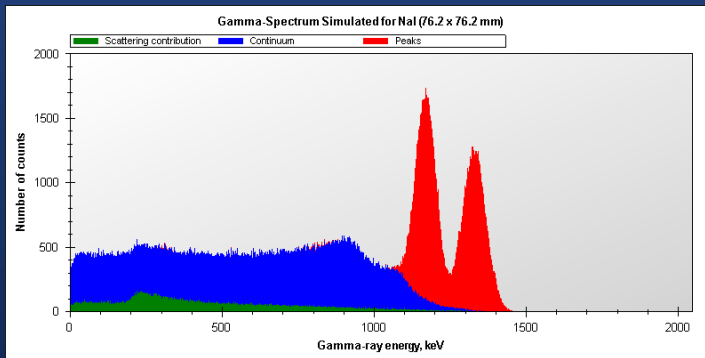
betas in air.mp4



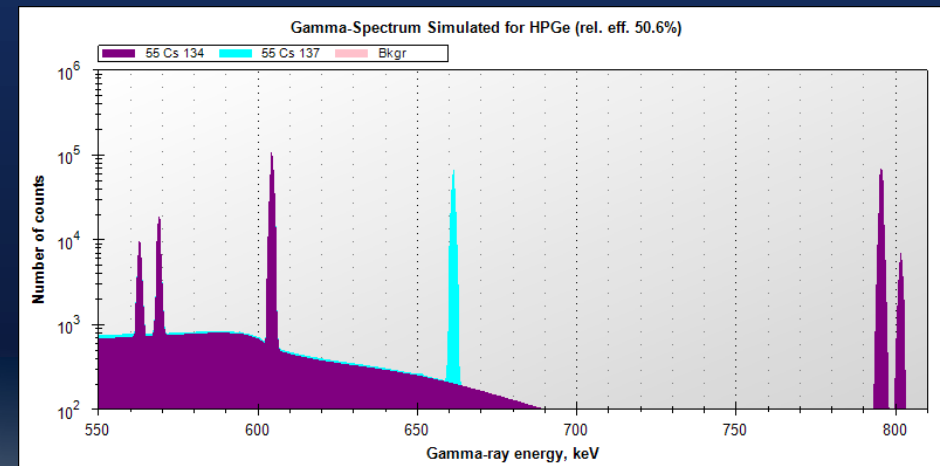
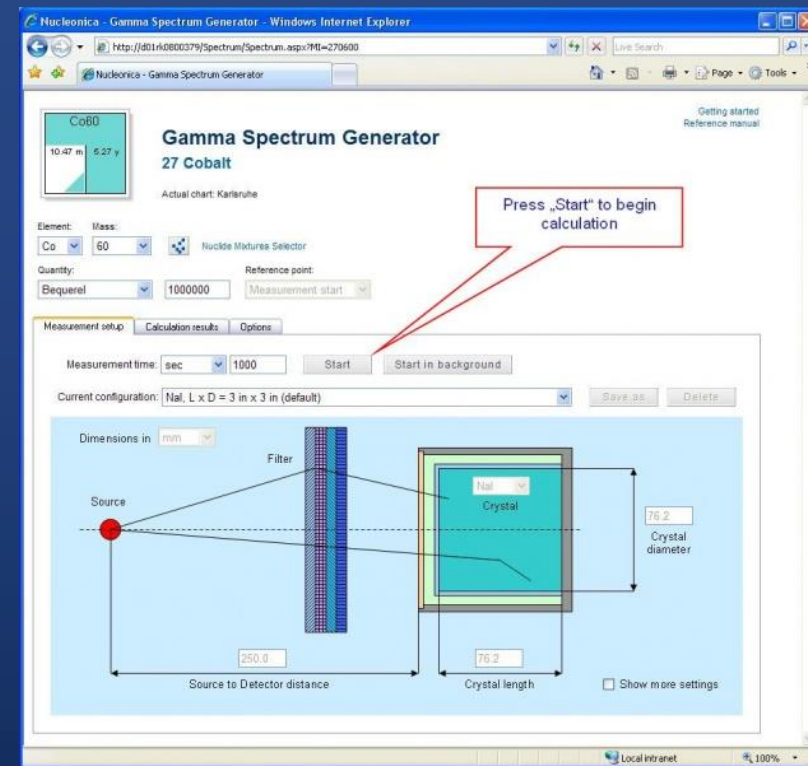
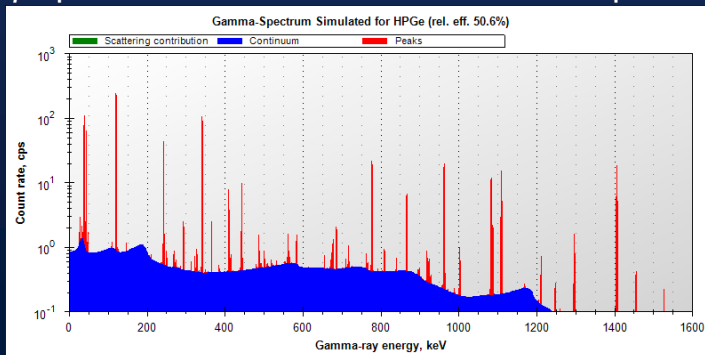
Electrons-positrons_inBfield_VR.mp4

Gamma Spectrum Generator

γ -spectrum simulated for ^{60}Co 100 kBq source and NaI (3" \times 3") detector:



γ -spectrum simulated for ^{152}Eu 100 kBq source and HPGe detector.



Fukushima: Gamma spectrum of contamination at the Daiichi plant.
Contamination is almost entirely to cesium-137 and cesium -134

Validated Nuclear Science Applications & Tools

webKORIGEN

fuel depletion calculations
& neutron activation



... web driven nuclear science

Applications Data Knowledge My Preferences Print Networking Nuclear Science Help New Browser

Version: 2012.08.09 17:55:51



webKORIGEN

Questions, remarks, suggestions can be posted in the [forum](#)

webKORIGEN was developed from the Oak Ridge Isotope Generation and Depletion code ORIGEN. Starting with a given initial reactor fuel or a single target nuclide, it calculates the time evolution of nuclide densities changing due to decays and neutron-induced reactions, and determines derived nuclear properties such as masses, radioactivities, heat releases, radiotoxicities, emission of radiation, etc...



webKORIGEN

Questions, remarks, suggestions can be posted in the [forum](#)

webKORIGEN was developed from the Oak Ridge Isotope Generation and Depletion code ORIGEN. Starting with a given initial reactor fuel or a single target nuclide, it calculates the time evolution of nuclide densities changing due to decays and neutron-induced reactions, and determines derived nuclear properties such as masses, radioactivities, heat releases, radiotoxicities, emission of radiation, etc...

Step 1: Calculation Mode

Step 2: Reactor / Operation

Step 3: Input Summary and Run

Step 4: Display Results

Step 5: Log files

Step 6: Parameters

Display results for nuclides/elements dominant at 6 y decay

Nuclides/Elements Radiations Nuclide Chart

Display quantity: Mass (g)

Filter:

Save as Mixture ...of up to 20 selected Nuclides

Plot	Z	Nuclides	Results	Plot	Z	Elements	Results	Plots	Totals	Nuclides	Elements	Results
<input type="checkbox"/>	55	Cs133	3.416e+4	<input type="checkbox"/>	92	Uranium	1.861e+7	<input checked="" type="checkbox"/>	Actinides+Progenies:	97	19	1.887e+7
<input checked="" type="checkbox"/>	55	Cs137	3.410e+4	<input type="checkbox"/>	94	Plutonium	2.276e+5	<input type="checkbox"/>	Actinides:	61	11	1.887e+7
<input type="checkbox"/>	55	Cs135	1.208e+4	<input type="checkbox"/>	54	Xenon	1.699e+5	<input type="checkbox"/>	Transuranium:	38	7	2.610e+5
<input checked="" type="checkbox"/>	55	Cs134	6.419e+2	<input type="checkbox"/>	60	Neodymium	1.252e+5	<input type="checkbox"/>	Minor Actinides:	21	3	3.341e+4
<input type="checkbox"/>	55	Cs136	5.206e-9	<input type="checkbox"/>	40	Zirconium	1.150e+5	<input type="checkbox"/>	Radon:	3	1	1.417e-9
<input type="checkbox"/>	55	Cs138	4.691e-10	<input type="checkbox"/>	42	Molybdenum	1.084e+5	<input checked="" type="checkbox"/>	Fission Products:	725	44	1.096e+6
<input type="checkbox"/>	55	Cs139	1.107e-10	<input checked="" type="checkbox"/>	55	Cesium	8.098e+4	<input type="checkbox"/>	Lanthanides:	138	12	3.174e+5
<input type="checkbox"/>	55	Cs140	9.061e-12	<input type="checkbox"/>	58	Cerium	7.809e+4	<input type="checkbox"/>	Rare Earths:	180	14	3.445e+5
<input type="checkbox"/>	55	Cs138m	6.910e-12	<input type="checkbox"/>	44	Ruthenium	7.039e+4	<input type="checkbox"/>	Noble Metals:	90	4	1.385e+5
<input type="checkbox"/>	55	Cs141	2.523e-12	<input type="checkbox"/>	56	Barium	5.764e+4	<input type="checkbox"/>	Inert Gases (Ne, Ar, Kr, Xe):	46	2	1.808e+5
<input type="checkbox"/>	55	Cs135m	1.396e-12	<input type="checkbox"/>	46	Palladium	5.336e+4	<input type="checkbox"/>	Hydrogen:	3	1	1.275e+0
<input type="checkbox"/>	55	Cs134m	1.228e-13	<input type="checkbox"/>	57	Lanthanum	3.918e+4	<input type="checkbox"/>	Helium:	1	1	9.335e+1
<input type="checkbox"/>	55	Cs142	5.938e-14	<input type="checkbox"/>	59	Praseodymium	3.635e+4	<input type="checkbox"/>	Total:	823	64	1.997e+7
<input type="checkbox"/>	55	Cs143	1.592e-14	<input type="checkbox"/>	62	Samarium	2.612e+4					
<input type="checkbox"/>	55	Cs144	1.650e-15	<input type="checkbox"/>	43	Technetium	2.462e+4					
<input type="checkbox"/>	55	Cs145	6.462e-17	<input type="checkbox"/>	38	Strontium	2.433e+4					
<input type="checkbox"/>	55	Cs146	2.443e-18	<input type="checkbox"/>	93	Neptunium	1.574e+4					
<input type="checkbox"/>	55	Cs147	6.569e-20	<input type="checkbox"/>	95	Americium	1.534e+4					
<input type="checkbox"/>	55	Cs148	9.250e-22	<input type="checkbox"/>	39	Yttrium	1.397e+4					

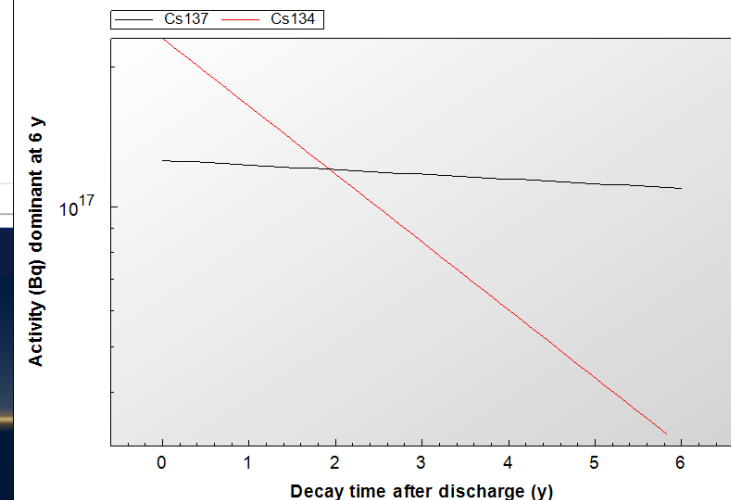
Reactor irradiation

Decay

Power
Flux

Reactor irradiation and decay

Nuclides during 6 y decay of 20 tHM PWR UOX 55 MWd/kg



Validated Nuclear Science Applications & Tools

e-Ship++:

package classification for radioactive transports

e-Ship: nuclear material transport report

Transport report generated for source: Irradiated sample (iron) by iss1 iss1 on Aug 21, 2013 11:24:31

DISCLAIMER: This tool is a help to choose the package classification, please always refer to the country specific regulations

Package name: Irradiated sample (iron)
Description: Package created from CERN spectrum file. The activity was reported on 27.2.2012.

Package characterisation: Material, Other form, Solid
Host material mass: 1 g
Activity reported: Feb 27, 2012 08:00:00

Please take care of subsidiary risk.

Chemical form:
For the definition of the quantities used in this report see the Nucleonica Glossary

Source characterisation

Data extracted from Swiss RPO, Appendix 3, pages 65... from 1 January 2013.

Nuclide	Half-life	Activity (Bq)	Heat (W)	Ambient dose rate H ₁₀ (μSv/h) at 10 cm	E _{ing} (mSv)	E _{inh} (mSv)	A(Bq) LE(Bq)	A(Bq/kg) LE(Bq/kg)	A(Bq) LA(Bq)	Radioactive contents	Notes
Be-7	53.22 d	3.11e+4	2.48e-10	2.49e-2	8.71e-4	1.71e-3	7.78e-2	7.78e+1	3.11e-4	(Bq)	
Co-58	77.31 d	1.88e+2	1.11e-10	9.02e-3	4.85e-4	1.25e-3	4.85e-2	4.85e+1	1.88e-4	(Bq)	
Co-57	271.80 d	1.02e+3	2.34e-11	2.14e-3	2.14e-4	1.02e-3	2.04e-2	2.04e+1	1.28e-4	(Bq)	
Co-58	70.86 d	7.22e+2	1.17e-10	1.05e-2	5.34e-4	1.52e-3	7.22e-2	7.22e+1	2.41e-4	(Bq)	
Co-60	5.271 y	1.19e+2	4.95e-11	4.38e-3	4.05e-4	3.05e-3	1.19e-1	1.19e+2	1.32e-3	(Bq)	
Mn-54	312.13 d	7.88e+2	1.05e-10	9.90e-3	5.58e-4	1.18e-3	7.88e-2	7.88e+1	1.97e-4	(Bq)	
Na-22	2.6027 y	5.25e+4	2.00e-8	1.73e+0	1.85e-1	6.83e-2	1.75e+1	1.75e+4	1.75e-2	(Bq)	
Sc-46	83.79 d	2.24e+2	7.80e-11	6.70e-3	3.36e-4	1.52e-3	3.20e-2	3.20e+1	2.24e-4	(Bq)	
Ta-182	114.7 d	3.23e+2	7.75e-11	6.27e-3	4.85e-4	3.23e-3	4.61e-2	4.61e+1	4.61e-4	(Bq)	
Y-88	106.63 d	1.45e+2	6.27e-11	5.51e-3	1.89e-4	6.38e-4	1.81e-2	1.81e+1	7.25e-5	(Bq)	
Total: 10		8.71e+4	2.09e-8	1.81e+0	1.72e-1	8.40e-2	1.80e+1	1.80e+4	2.06e-2		

Package characterisation

Data extracted from ADR Table of A₁, A₂ values, exemption limits and notes (pages 218...)

Nuclide	Activity (Bq)	A ₁ (TBq)	Exempt (Bq)	Exempt (Bq/g)	Exempt (GBq)	A ₂ (TBq)	A ₂ Exempt	A (Bq/g) Exempt(Bq/g)	A Exempt
Be-7	3.11e+4	2.00e+1	1.00e+7	1.00e+3	2.00e+1	1.55e-9	3.11e-3	3.11e+1	1.55e-8
Co-58	1.88e+2	3.00e+1	1.00e+5	1.00e+1	3.00e-1	6.20e-10	1.88e-3	1.88e+1	6.20e-7
Co-57	1.02e+3	1.00e+1	1.00e+8	1.00e+2	1.00e+1	1.02e-10	1.02e-3	1.02e+1	1.02e-7
Co-58	7.22e+2	1.00e+0	1.00e+5	1.00e+1	1.00e+0	7.22e-10	7.22e-4	7.22e+1	7.22e-7
Co-60	1.19e+2	4.00e+1	1.00e+5	1.00e+1	4.00e-1	2.98e-10	1.19e-3	1.19e+1	2.98e-7
Mn-54	7.88e+2	1.00e+0	1.00e+5	1.00e+1	1.00e+0	7.88e-10	7.88e-4	7.88e+1	7.88e-7
Na-22	5.25e+4	5.00e+1	1.00e+8	1.00e+1	5.00e-1	1.05e-7	5.25e-2	5.25e+3	1.05e-4
Sc-46	2.24e+2	5.00e+1	1.00e+5	1.00e+1	5.00e-1	4.48e-10	2.24e-4	2.24e+1	4.48e-7
Ta-182	3.23e+2	5.00e+1	1.00e+4	1.00e+1	5.00e-1	6.46e-10	3.23e-2	3.23e+1	6.46e-7
Y-88	1.45e+2	4.00e+1	1.00e+5	1.00e+1	4.00e-1	3.83e-10	1.45e-4	1.45e+1	3.83e-7
Total: 10	8.71e+4					1.11e-7	9.39e-2	5.54e+3	1.11e-4

Package Exempt from regulation



e-Ship++

radiological transport assistant

This is a beta version of the new web application e-Ship++. Please report errors to info@nucleonica.com.

DISCLAIMER: This tool is a help to choose the package classification, please always refer to the country specific regulations.

My Packages Edit Options Decay Import Activity limits Swiss RPO Sample packages About e-Ship

User defined transport packages

Package Name	Mass (g)	Items	Content	Form	State	Activity reported	last modified	Download	Delete
(Create, import a new package)									
1g irradiated UOX fuel	1		Material	Other	Solid	2013.08.01 08:12:23	2013.08.01 08:12:23		
ISOLDE Target	25000		Material	Other	Solid	2013.04.14 17:28:38	2013.04.15 09:14:00		
Decayed: Sr83	1		Material	Other	Solid	2013.04.11 16:50:25	2013.04.11 16:53:37		
Spectro	1		Material	Other	Solid	2012.01.06 08:00:00	2012.08.22 13:11:36		
Irradiated sample using 26 GeV protons	1		Material	Other	Solid	2012.05.24 08:00:00	2012.08.22 12:35:15		
Irradiated sample (iron)	1		Material	Other	Solid	2012.02.27 08:00:00	2012.08.22 11:46:31		
Simple Package (Exempted)	1		Material	Other	Solid	2012.08.10 08:00:00	2012.08.22 11:23:31		
My 1st Package (Type A)	5		Material	Other	Solid	2012.08.03 08:00:00	2012.08.22 11:15:18		
My 1st Package (Exempted)	10		Material	Other	Solid	2012.08.02 08:00:00	2012.08.22 11:13:16		
My 1st Package (Exempted)	150		Material	Other	Solid	2012.08.01 08:00:00	2012.08.22 11:02:28		
Total: 10									

This is a beta version of the new web application e-Ship++. Please report errors to info@nucleonica.com.



DISCLAIMER: This tool is a help to choose the package classification, please always refer to the country specific regulations.

My Packages Edit Options Decay Import Activity limits Swiss RPO Sample packages About e-Ship

Name (ID=1203)

Irradiated sample (iron)

Chemical form (please take care of subsidiary risk):

Description:

Package created from CERN spectrum file. The activity was reported on 27.2.2012.

Activity reported: 2012.02.27 08:00:00

Package characteristics

Content
☒ Material
☐ Instruments / Articles

Form
☒ Other
☐ Special

State
☒ Solid
☐ Liquid
☐ Gas

Host material: 1 g

Nuclide	Activity A (Bq)	Mass (g)	Half-life	A ₁ (TBq)	A ₂ (TBq)	Exempt (GBq)	Exempt (Bq)	Exempt (Bq/g)	A ₁ A ₂	A Exempt	A (Bq) Exempt(Bq)	A (Bq/g) Exempt(Bq/g)
Be-7	3.11e+4	2.40e-12	53.22 d	20	20	20.0	1.00e+07	1.00e+03	1.55e-9	1.55e-6	3.11e-3	31.1
Co-56	186	1.66e-13	77.31 d	0.3	0.3	0.300	1.00e+05	1.00e+01	6.20e-10	6.20e-7	1.86e-3	18.6
Co-57	1.02e+3	3.27e-12	271.80 d	10	10	10.0	1.00e+06	1.00e+02	1.02e-10	1.02e-7	1.02e-3	10.2
Co-58	722	6.14e-13	70.86 d	1	1	1.00	1.00e+06	1.00e+01	7.22e-10	7.22e-7	7.22e-4	72.2
Co-60	119	2.84e-12	5.271 y	0.4	0.4	0.400	1.00e+05	1.00e+01	2.98e-10	2.98e-7	1.19e-3	11.9
Mn-54	786	2.74e-12	312.13 d	1	1	1.00	1.00e+06	1.00e+01	7.86e-10	7.86e-7	7.86e-4	78.6
Na-22	5.25e+4	2.27e-10	2.6027 y	0.5	0.5	0.500	1.00e+06	1.00e+01	1.05e-7	1.05e-4	5.25e-2	5.25e+3
Sc-46	224	1.79e-13	83.79 d	0.5	0.5	0.500	1.00e+06	1.00e+01	4.48e-10	4.48e-7	2.24e-4	22.4
Ta-182	323	1.40e-12	114.7 d	0.9	0.5	0.500	1.00e+04	1.00e+01	6.46e-10	6.46e-7	3.23e-2	32.3
Y-88	145	2.81e-13	106.63 d	0.4	0.4	0.400	1.00e+06	1.00e+01	3.62e-10	3.63e-7	1.45e-4	14.5
Total: 10	8.712e+4	2.409e-10							1.11e-7	1.11e-4	9.39e-2	5.54e+3

Element Mass Property Quantity Unit
Y 88 145 Becquerel
Save Package Reset Cancel Report Update

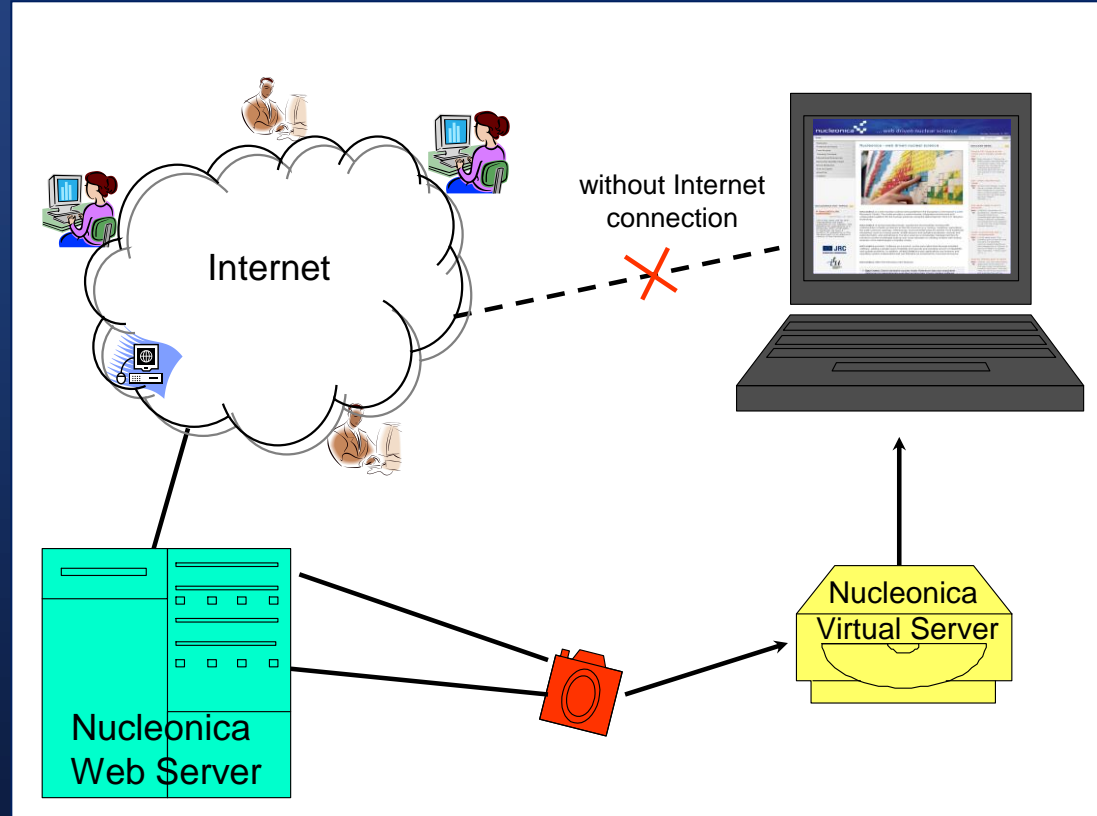
Education & Training with Nucleonica

Nucleonica for Smartphones: and Tablet PCs: M-Learning



Standalone version of Nucleonica

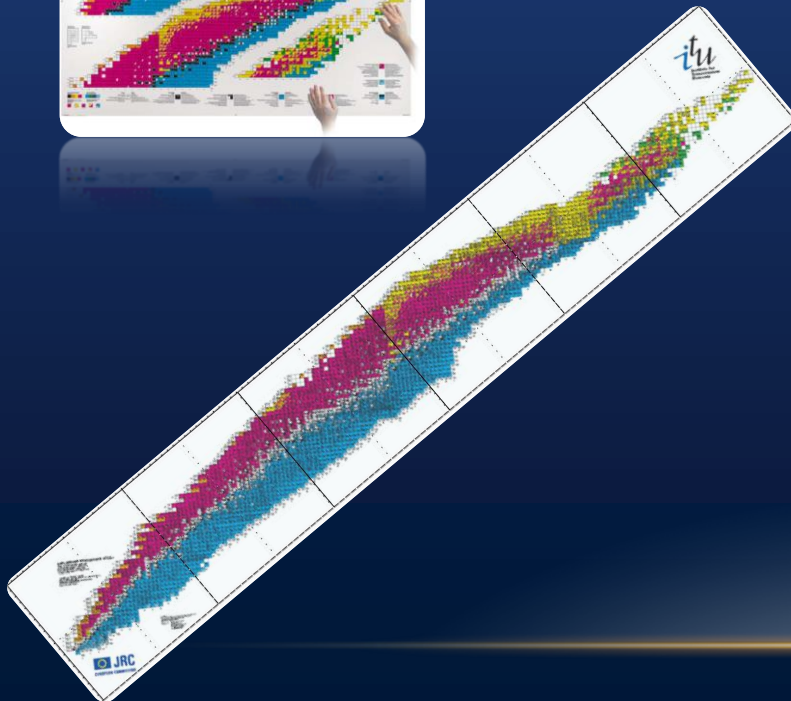
- specially developed for mobile labs and field workers or for use on Notebooks/PCs where an internet connection cannot be guaranteed
- faster than internet version
- allows for more particles in Monte Carlo calculations than the internet version
- allows Monte Carlo dosimetry and shielding calculations (provided you have an MCNP license!)



Karlsruhe Nuclide Chart



- Fold-out Chart
- Wall-Chart
- Auditorium Chart
- Nuclide Carpet



Nuclide „carpet“
1m x 6.5m



New Roll Map version of the Karlsruhe Nuclide Chart

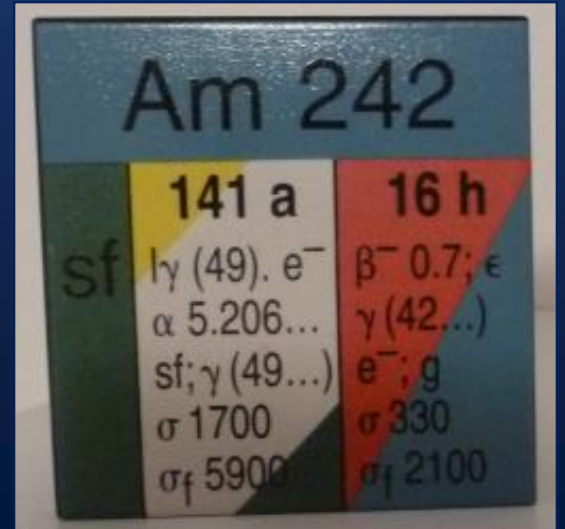
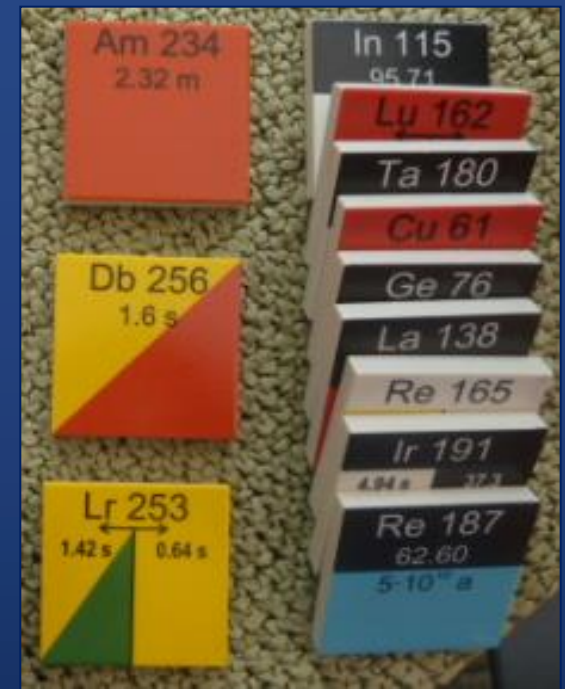


with clamping rails and
suspension system for
easy mounting...



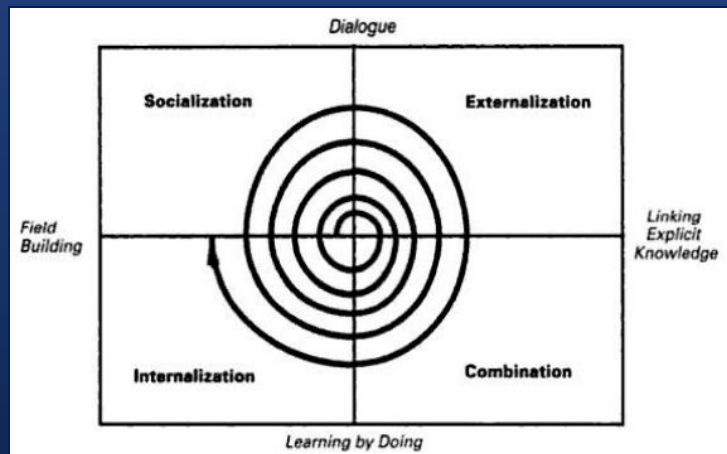
Unique mosaic tiles for the
Institute for
Transuranium
Elements,
Karlsruhe

15m x 7m

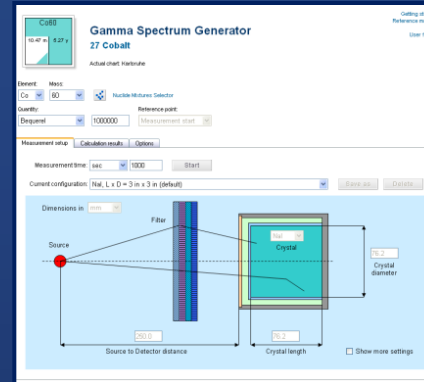


Knowledge Management with Nucleonica

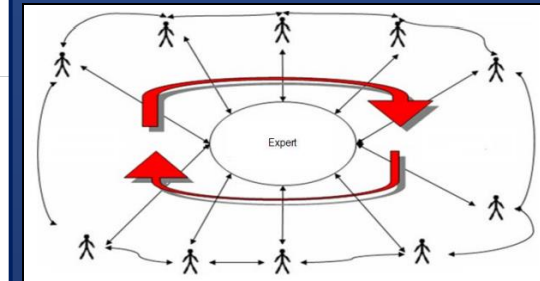
In this slide, the Nucleonica web portal is considered from a knowledge management perspective. Nonaka and Takeuchi have proposed the “knowledge spiral” (shown) in which there are four modes of knowledge conversion: socialization, externalization, combination and internalization (SECI model).



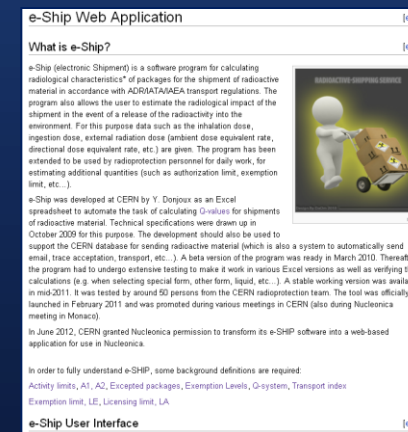
Socialisation: conversion of tacit knowledge to tacit knowledge e.g. an apprentice who works with tutor and learns from observing and imitating the tutor's actions. **Externalization:** conversion of tacit to explicit knowledge. **Combination** is the conversion of explicit to explicit knowledge. The process of systemizing already explicit knowledge into a knowledge system. **Internalization** is the conversion from explicit to tacit, which is closely related to “learning by doing”. At the end of the spiral process, one or more individuals in the organisation have acquired new tacit knowledge.



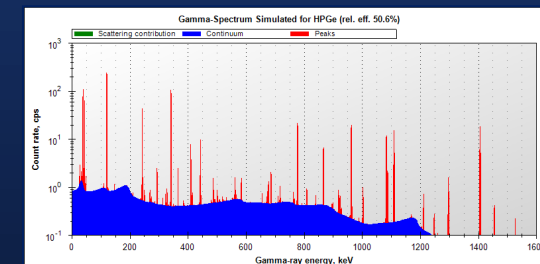
Socialisation: conversion of tacit knowledge to tacit knowledge



Externalization: conversion of tacit to explicit knowledge



Combination: systemizing explicit knowledge

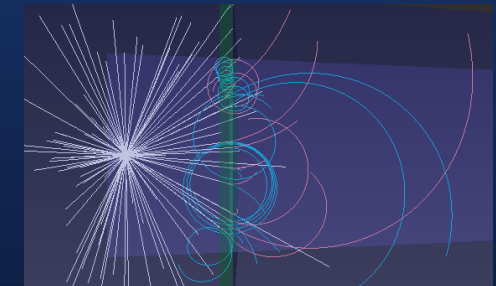
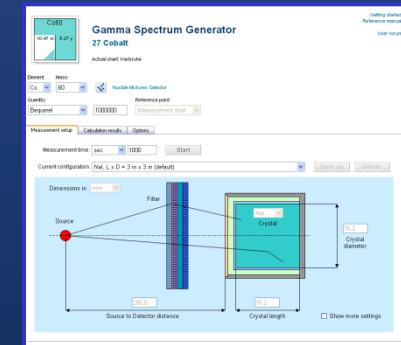
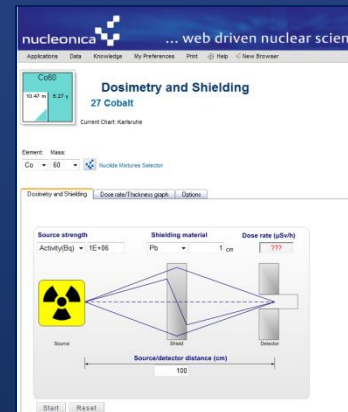


Internalization: conversion from explicit to tacit, triggered through “Learning by Doing”.

Nucleonica: Web-based Software Tools for Simulation and Analysis



- Nuclear Data Resources in Nucleonica
- Nuclear Science Applications & Tools
 - Decay Engine
 - Dosimetry & Shielding
 - Virtual Cloud Chamber
 - Gamma Spectrum Generator
 - webKORIGEN
 - e-Ship
- Education & Training with Nucleonica
 - Nucleonica Mobile
 - Karlsruhe Nuclide Chart
- Knowledge Management with Nucleonica





[category](#) | [discussion](#) | [edit](#) | [history](#) | [delete](#) | [watch](#)

Category:Glossary

This Glossary is based mainly on the following sources:

1. J. Magill and J. Galy, [Radioactivity Radionuclides Radiation](#) & Springer Verlag, 2005
2. J. Magill, G. Pfennig, J. Galy, [Karlsruhe Nuclide Chart](#), 7th Edition, 2006.
3. Additional information can be found in the IAEA [Safety Glossary](#), Terminology Used in Nuclear Safety and Radiation Protection 2007 Edition.
4. See also the CTBTO glossary <http://www.ctbto.org/glossary/> &

Articles in category "Glossary"


There are 179 articles in this category.

[navigation](#)

- [Help](#)
- [Glossary](#)
- [Element Information](#)
- [ReadingRoom](#)
- [Gallery of Nuclear Science](#)
- [Weblinks](#)
- [Karlsruhe Nuclide Chart](#)
- [Premium Membership](#)

[support](#)

	page	discuss	view source	history	delete	unwatch
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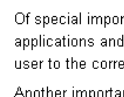


Main Page

Welcome to the Nucleonica Wiki!

The Nucleonica wiki is an open knowledge resource for the nuclear sciences. In contrast to Wikipedia, which can be edited by anyone, the Nucleonica wiki articles are written by experts and practitioners in the field and cannot be edited. The Nucleonica wiki is devoted specifically to nuclear science. Wiki technology is best suited for this purpose since it allows addition of content at any time from any location.

Another aim the Nucleonica wiki is to provide the technical documentation in support of the Nucleonica nuclear science portal www.nucleonica.com. Whereas the Nucleonica portal requires [registration](#) to access its applications and data pages, the wiki is an "open" knowledge resource.



navigation

- Main Page
- Help
- Glossary
- Element Information
- ReadingRoom
- Gallery of Nuclear Science
- Weblinks
- Karlsruhe Nuclide Chart
- Premium Membership

How this Wiki is organized

The Sidebar panel to the left of this window provides quick links to a number of important pages in this wiki. The links are grouped under:

support

- Training Courses
- Case Studies
- Nucleonica Support

tools

- Recent changes
- Random page

search

toolbox

- What links here
- Related changes
- Upload file
- Special pages
- Printable version
- Permanent link

	E cont.	O
	▪ Exemption Levels	▪ Orphan source
	F	P
ed Dose	▪ Fermion	▪ Pair production
e(s)	▪ Find	▪ Parity
Exposure	▪ Fissile	▪ Particle Therapy
ecay	▪ Fission	▪ Photon
article	▪ Fundamental forces	▪ Physical protection
Limit of Intake (ALI)	G	▪ Polonium 210
tter	▪ Gamma radiation	▪ Positron
Weight	▪ Geological repository	▪ Primordial radionuclides
mass	▪ Glioblastoma	▪ Proton
number	▪ Gram atom	Q
effect	▪ Gray, (Gy)	▪ Quality factor
	H	R
	▪ HASS Directive	▪ RCM
Boron Neutron Capture Therapy)	▪ Hadron	▪ RDD
	▪ Hadron Therapy	▪ RDE

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Help:Decay Engine

Create [html file](#) for this document

Contents [hide]

- 1 Overview**
 - [1.1 Simple Radioactive Decay](#)
 - [1.2 Radioactive Decay Chains](#)
 - [1.3 Convergent and Divergent Branches](#)
 - [1.4 Radioactive Equilibrium](#)
 - [1.4.1 \(\$t_1 \gg t_2\$ \): Secular Equilibrium:](#)
 - [1.4.2 \(\$t_1 \approx t_2\$ \): Transient Equilibrium](#)
 - [1.4.3 \(\$t_1 < t_2\$ \): The Half-life of the Parent is Shorter than that of the Daughter](#)
 - [1.4.4 \(\$t_1 \approx t_2\$ \): The Half-lives of the Parent and Daughter are Similar](#)
- 2 Using the Decay Engine Module**
 - [2.1 User Interface](#)
 - [2.2 Options](#)
 - [2.3 Graph](#)
 - [2.4 Details](#)
- 3 References**

Overview

Simple Radioactive Decay

Radioactive decay is a random process. It is not possible to predict when a particular nucleus will decay, however, evaluate the probability that a nucleus will decay in a time interval. This was first identified by Rutherford, is

$$\frac{dQ}{dt} = -kQ$$

Start of the Name Approval Process for the Elements of Atomic Number 114 and 116

February 19th, 2012

by Joseph Magill

A joint IUPAC/IUPAP Working Party (JWP) has confirmed the discovery of the elements with atomic numbers 114 and 116. In accord with IUPAC procedures, the discoverers proposed names as follows: flerovium and symbol, Fl, for the element with $Z = 114$ and livermorium with the symbol Lv for the element with $Z = 116$. The Inorganic Chemistry Division recommended these proposals for acceptance.

Comments should be submitted by 30 April 2012. The text of the Provisional Recommendation can be downloaded from


http://media.iupac.org/reports/provisional/abstract11/corish_300412.html.

Comments should be sent to Prof. John Corish at jcorish@tcd.ie.

116				Lv	Lv 290 7.1 ms α 10.84	Lv 291 18 ms α 10.74	Lv 292 18 ms α 10.66	Lv 293 53 ms α 10.63
115		Uup	Uup 287 32 ms α 10.69	Uup 288 87 ms α 10.46	Uup 289 0.22 s α 10.31	Uup 290 ~16 ms α 9.96	176	
114	Fl	Fl 285 ~125 ms α	Fl 286 0.13 s β^- α 10.19	Fl 287 0.48 s α 10.02	Fl 288 0.69 s α 9.96	Fl 289 2.1 s α 9.87		

Extract from the new 8th Edition (2012) of the Karlsruhe Nuclide Chart showing the isotopes of flerovium and livermorium.

The Nucleonica Forum...



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If this is your first visit, be sure to check out the [FAQ](#) by clicking the link above. You may have to [register](#) before you can post: click the register link above to proceed. To start viewing messages, select the forum that you want to visit from the selection below.

Threads 1 to 20 of 105

Page 1 of 6

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2

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...





















▶

Last ▶▶

Forum: General
 General comments

Forum Tools

Search Forum

Title / Thread Starter	Replies / Views	Last Post By
 Emergency preparedness analysis for decision-making Jeremie Muswema	Replies: 0 Views: 21	Jeremie Muswema 13-04-12 13:02 
 Core Inventory calculations Jeremie Muswema	Replies: 1 Views: 20	HotCells 12-04-12 18:34 
 Functionality of the "Gamma Library" Niko	Replies: 4 Views: 80	Jeremie Muswema 12-04-12 17:52 
 Being notified for a new thread in the forum SpectrO	Replies: 4 Views: 314	SpectrO 15-03-12 10:59 
 Reference book or paper about cross section for neutron induced reactions Giancarlo D'Agostino	Replies: 1 Views: 227	jmagill 09-02-12 07:44 
 Free users and WESPA jivko	Replies: 1 Views: 243	jmagill 30-01-12 14:49 
 NuTroNS-2 Monte Carlo, Monaco jmagill <div>1 2</div>	Replies: 10 Views: 2,047	zeynepyarar 17-11-11 22:09 
 Fission products from spontaneous fission FAQ	Replies: 1 Views: 246	FAQ 09-11-11 07:17 
 webKORIGEN output in EXCEL format XRay	Replies: 1 Views: 599	HotCells 26-09-11 18:26 
 Why does HEU produce fewer counts than pure U235 in the Gamma Spectrum Generator? XRay	Replies: 1 Views: 464	HotCells 22-09-11 12:02 

The Nucleonica Glossaries...

The screenshot shows the Nucleonica Wiki interface. At the top, there are tabs for 'category', 'discussion', 'view source', and 'history'. The main heading is 'Category:Glossary'. Below it, a note states: 'Additional information can be found in the IAEA Safety Glossary: Terminology Used in Nuclear Safety and Radiation Protection 2007 Edition.' A red circle highlights the text 'Sub-categories Packaging, Nuclear Data'. Below this, the heading 'Pages in category "Glossary"' is shown, followed by the text 'The following 200 pages are in this category, out of 260 total.' and '(previous 200) (next 200)'. The page lists various terms under alphabetical headings: A, D cont., K cont., L, M, Q, R, S. A red arrow points from the 'category' tab to the 'category' tab in the smaller screenshot below.

category discussion view source history

Category:Glossary

Additional information can be found in the IAEA Safety Glossary: Terminology Used in Nuclear Safety and Radiation Protection 2007 Edition.

Sub-categories Packaging, Nuclear Data

Pages in category "Glossary"

The following 200 pages are in this category, out of 260 total.
(previous 200) (next 200)

A

- A1, A2
- Absorbed Dose
- Abundance
- Actinide(s)
- Activated material
- Activity
- Activity limits
- Acute Exposure
- ADR
- ALARA
- ALARP
- ALI
- Alpha decay
- Alpha particle
- AMAD
- Ambient dose equivalent H*(10)
- Annual Limit of Intake
- Annual Limit of Intake (ALI)
- Antimatter
- Atom
- Atomic mass
- Atomic number
- Atomic Weight
- Packaging

D cont.

- Decay constant
- Decay modes
- Decommissioning
- Decontamination
- Depleted uranium
- Derived air concentration (DAC)
- Derived water concentration (DWC)
- Detection/monitoring
- Disintegration
- Dose
- Dose coefficient, e(t)
- Drip-lines

E

- E-Ship++
- Effective dose coefficient
- Effective dose, E
- Electromagnetic Radiation
- Electron
- Electron capture
- ENDF/B-VII-1
- Enriched uranium
- Equivalent dose, H

K cont.

- KNK-II

L

- Lanthanides
- Lepton
- Lethal dose
- Licensing limit, LA
- Light water
- LLW
- LNT
- Low enriched uranium (LEU)
- Low specific activity LSA
- LWR

M

- Magic numbers
- Mass defect
- Mass excess
- Mass number
- Mean decay energies
- Mean lifetime
- Minor Actinide
- Moderator
- Mole

Q

- Q-system

R

- Radiation weighting factors
- Radioactive contents
- Radioactive material
- Radiological limits

S

- Sealed source
- Shipment
- Special form
- Special nuclear material
- Surface contaminated object SCO

nucleonica [wiki]

navigation

- Main Page
- Help
- Glossary
- Element Information
- ReadingRoom
- Gallery of Nuclear Science
- Weblinks
- Karlsruhe Nuclide Chart
- Premium Membership

support

- Training Courses
- Case Studies
- Nucleonica Support

tools

- Recent changes
- Random page

search

Go Search

toolbox

- What links here
- Related changes
- Special pages
- Printable version
- Permanent link

category discussion view source history

Category:Glossary.Packaging

All Glossary articles related to Transport & Packaging

General References:

IAEA Safety Glossary: Terminology Used in Nuclear Safety and Radiation Protection

ADR 2013: Volume I: Agreement and Protocol of Signature; Annex A: Parts 1 and 2

Swiss Radiological Protection Ordinance (RPO)

Nucleonica's e-Ship++

Pages in category "Glossary.Packaging"

The following 60 pages are in this category, out of 60 total.

A

- A1, A2
- Absorbed Dose
- Activated material
- Activity limits
- ADR
- ALI
- Ambient dose equivalent H*(10)
- Annual Limit of Intake
- Annual Limit of Intake (ALI)

C

- ReadingRoom: Clearance
- Committed effective dose, E
- Committed equivalent dose, H
- Consignment
- Consignor
- Contaminated material
- Contamination

D cont.

- Dose
- Dose coefficient, e(t)

E

- E-Ship++
- Effective dose coefficient
- Effective dose, E
- Enriched uranium
- Equivalent dose, H
- Excepted packages
- Exempted
- Exemption Levels
- Exemption limit, LE

G

- Guidance value

H

Thank You!

Nucleonica: Tips & Tricks

1. Using browser tabs
2. Using the wiki context sensitive Help
3. Accessing the Nucleonica blog
4. Increase font size in your browser
5. Using the datagrid / slider control to rearrange data
6. Increase the default size of graphs in your web browser
7. How to change your login username and password



The screenshot displays the Nucleonica website. At the top, there is a navigation bar with links: Home | Sitemap | About us | Privacy Statement | Legal Notice. The Nucleonica logo is on the left, and the tagline "... web driven nuclear science" is on the right. Below the navigation bar, there is a login section with fields for "username" and "password", and buttons for "AutoLogin" and "Login".

On the left side, there is a sidebar menu with the following links: Welcome, Free Access, Premium Membership, Our Customers, Nucleonica [blog], Nucleonica [wiki], Forum, Karlsruhe Nuclide Chart, Online Shop, Educational Resources, Training Courses, Ask an Expert, FAQ, About Us, Contact, and Impressum.

The main content area features a large image of a hand pointing at a periodic table of elements. Below this image, there is a section titled "What is Nucleonica?" with several paragraphs of text. To the right of the main content, there is a "NUCLEAR NEWS" section with several news items, each with a date and a brief description.

At the bottom of the main content area, there is a section titled "NUCLEONICA HOT TOPICS" with a link to "New! Virtual Cloud Chamber" dated November 10, 2011. Below this link, there is a short paragraph of text.